

Options for a Gulf States' Mercury Advisory for King Mackerel

Donald M. Axelrad¹, Curtis D. Pollman²,
George E. Henderson³, and Frederick Kopfler⁴

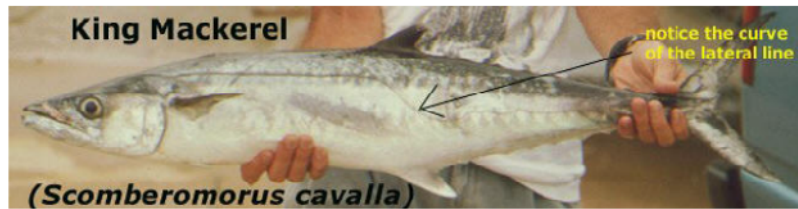
¹Florida Department of Environmental Protection

²Tetra Tech Inc.

³Florida Fish and Wildlife Conservation Commission

⁴USEPA Region 4 Gulf of Mexico Program Office





Family Scombridae – Mackerels and Tunas

Geographical Distribution: Western Atlantic from Massachusetts to Rio de Janeiro, Brazil.

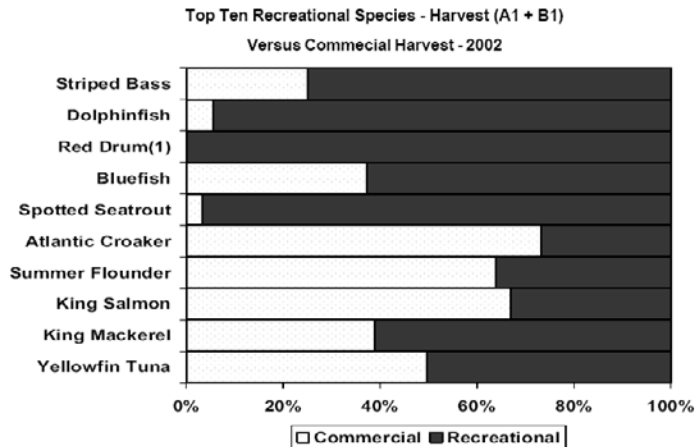
Interest to Fisheries: King mackerel is an important species for recreational and commercial fisheries throughout its range.

Size: Maximum size is 173 cm fork length and 45 kg weight.

Food: Food consists primarily of fishes with smaller quantities of penaeid shrimps and squids.



Top ten marine fish species in descending order of US recreational catch by weight, and comparison of recreational vs. commercial catch (NMFS)



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2002 U.S. Recreational Landings (NMFS)

King Mackerel

- **6,769,000 pounds**
(3,043,000 pounds from the Gulf)
- **690,000 fish**

2002 U.S. Commercial Landings (NMFS)

King Mackerel

- 4,471,000 pounds
(2,179,000 pounds from the Gulf)
- \$6,291,000 in value

U. S. Food and Drug Administration
May 2001 |

Mercury Levels in Seafood Species

Table 1
Fish With Highest Mercury Levels

SPECIES	MEAN (PPM)	RANGE (PPM)	NO. OF SAMPLES
Tilefish	1.45	0.65-3.73	60
Swordfish	1.00	0.10-3.22	598
King Mackerel	0.73	0.30-1.67	213
Shark	0.96	0.05-4.54	324

Mercury Levels in Seafood Species

Table 2
Fish and Shellfish With Much Lower Mercury Levels

SPECIES	MEAN (PPM)	RANGE (PPM)	NO. OF SAMPLES
Grouper (Mycteroperca)	0.43	0.05-1.35	64
Tuna (fresh or frozen)	0.32	ND-1.30	191
*Lobster Northern (American)	0.31	0.05-1.31	88
Grouper (Epinephelus)	0.27	0.19-0.33	48
*Halibut	0.23	0.02-0.63	29
*Sablefish	0.22	ND-0.70	102
*Pollock	0.20	ND 0.78	107
*Tuna (canned)	0.17	ND-0.75	248



**AN IMPORTANT MESSAGE FOR PREGNANT
WOMEN AND WOMEN OF CHILDBEARING AGE
WHO MAY BECOME PREGNANT
ABOUT THE RISKS OF MERCURY IN FISH**

You can protect your unborn child by not eating these large fish that can contain high levels of methylmercury:

Shark
Swordfish
King mackerel
Tilefish



For Immediate Release

June 4, 1996

HEALTH ADVISORY FOR KING MACKEREL

TALLAHASSEE – The Florida Department of Health and Rehabilitative Services and the Department of Environmental Protection today jointly announced a health advisory urging limitations on consumption of King Mackerel caught from the Gulf of Mexico. **Mercury in King Mackerel increased with size and age of fish. Based on this relationship the advisory is as follows:**

<u>Fish Size</u>	<u>Mercury Level</u>	<u>Advisory</u>
Less than 33"	< 0.5 ppm	Safe for unrestricted consumption
33 to 39 inches	0.5 to 1.5 ppm	Adults: one 8-oz.meal/week. Women of childbearing age and children: one 8-oz. meal/month
More than 39"	> 1.5 ppm	Should not be consumed

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FLORIDA DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

March 3, 1989

TO: Charles S. Mahan, M.D., State Health Officer
FROM: Richard W. Freeman, Ph.D., Director, Toxicology
SUBJECT: Exposure Guidelines for Mercury in Fish

"The WHO RfD (0.43 µg MeHg/kg-body weight/day), ..., is, I think, the best estimate of risk from exposure to MeHg (methylmercury) in fish flesh.

"For the 0.5 to 1.5 ppm range of mercury values, adults should restrict intake to one meal per week unless the person is pregnant, a lactating female, a female intending to become pregnant or a child less than 15 years of age. In this latter case, intake should be restricted to one meal per month."

0.43 µg/kg body weight/day / 4.3 weeks per month = 0.1 µg/kg body weight/day

or, for women of childbearing age and children, **Florida's MeHg RfD since 1989 has been equivalent to USEPA's current MeHg RfD.**

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Comparison of Gulf of Mexico States' Consumption Advisories for King Mackerel re Mercury

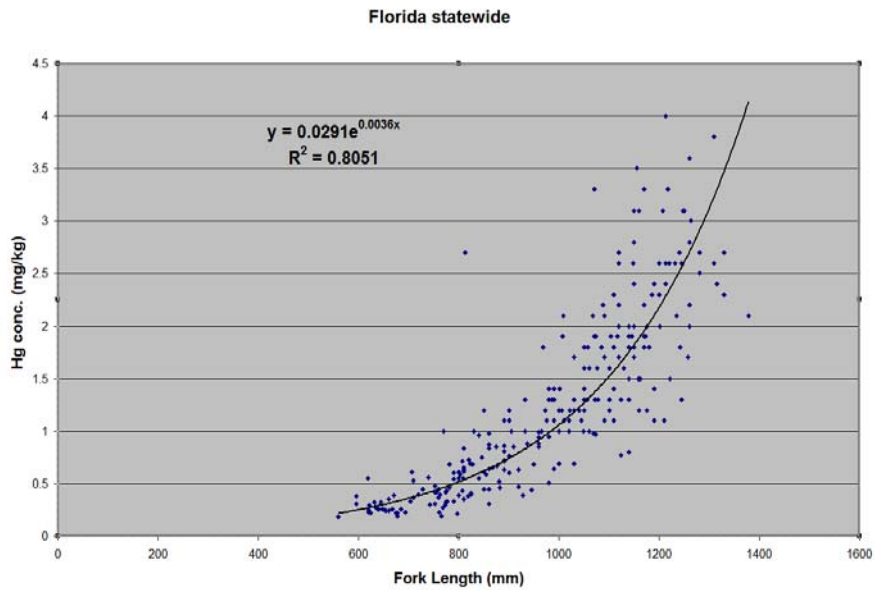
State	No Consumption	Adults – Limited Consumption	Women of Childbearing Age – Limited Consumption	Children – Limited Consumption
Florida	> 39" fork length	33" to 39" one meal per week	One meal per month	< 11 years old, one meal per month
Alabama	> 39"	< 39" one meal per month	No consumption	< 15, no consumption
Mississippi	> 39"	33" to 39" one meal every two weeks	One meal every two months	< 7, one meal every two months
Louisiana	> 39" total length	< 39" four meals per month	One meal per month	< 7 years, one meal per month
Texas	> 43" total length.	37" to 43" one meal per week	One meal per month	No defined age one meal per month

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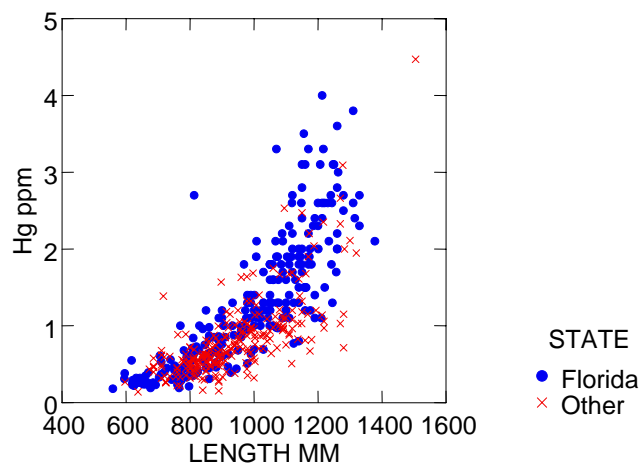
Differences in King Mackerel advisories among the five Gulf of Mexico States:

- RfD
- Age defined as a child
- Advised rates of fish consumption by fish size and Hg concentration categories
- Fish size ranges for categories of fish consumption limitation
- Gulf-wide advisory based on fish size?
Requires a consistent mercury concentration - fish size relationship

Florida Gulf and Atlantic King Mackerel, Fish Size vs. Mercury

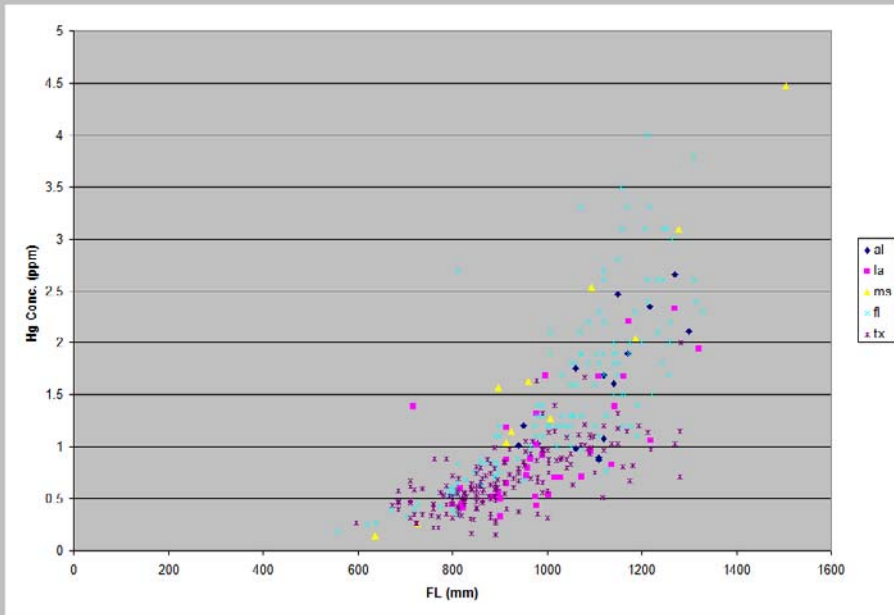


King Mackerel Size vs. Hg, Florida Data¹ and Other Gulf States Data

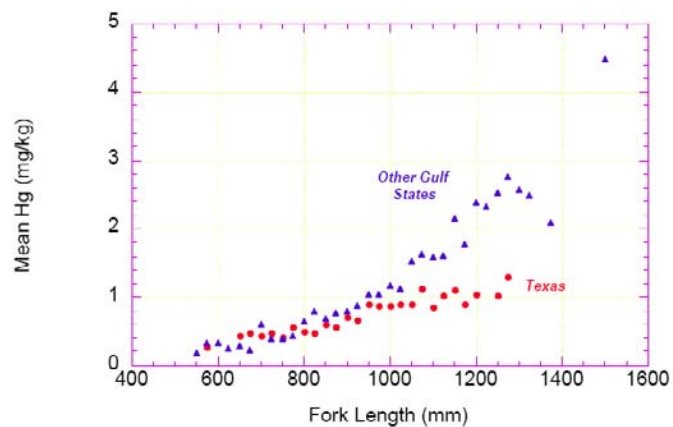


¹Includes Atlantic sites

King Mackerel Size vs. Hg Concentration for All Gulf of Mexico States



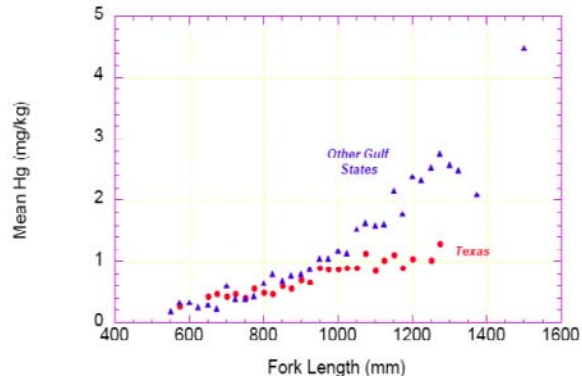
King Mackerel Hg as a Function of Fork Length Class.



Data pairs represent mean mercury concentration for King Mackerel for 25mm fork length size classes.

***Below ca. 1000 mm**, the fork length - mercury concentration relationship appears identical for fish from Texas and the other Gulf States.

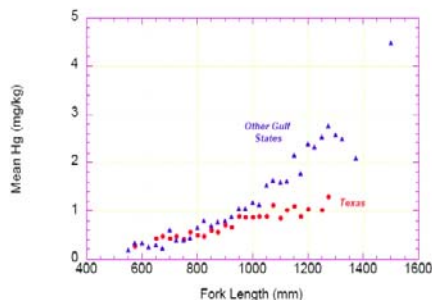
*** Above ca. 1000 mm**, for Texas King Mackerel the slope of the fork length - mercury concentration relationship diverges from that for fish from the other Gulf States.



Results of a paired t-test indicate:

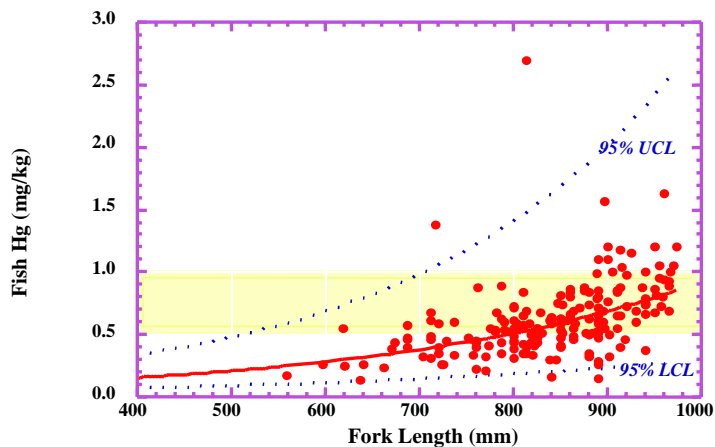
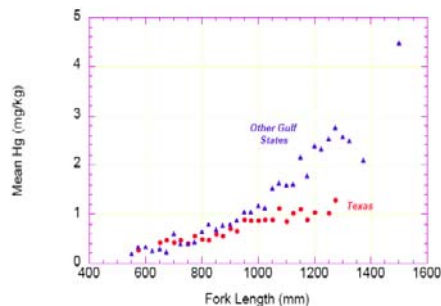
***For size classes < 950 mm** (i.e., fish 950 – 974 mm in fork length), the mean mercury concentration difference between fish from Texas and those from other Gulf States is statistically insignificant: -0.041 mg/kg , $p = 0.3067$

***For size classes > 950 mm**, the mean mercury concentration difference between fish from Texas and those from other Gulf States is statistically significant : -0.730 mg/kg , $p = 0.0002$



*Note that for the fish size class at which the King Mackerel fork length – mercury concentration relationship diverges between Texas and the other Gulf States, the mercury concentration is ca. 1 mg/kg, and above the concentration for which fish consumption would be recommended.

*As such, **there is scope for a for a Gulf-wide King Mackerel consumption advisory** for fish < 975 mm (38.4 inches) in fork length and < 1 mg/kg in mercury concentration.



Plot of mercury concentrations vs. fork length for King Mackerel collected in the Gulf of Mexico by the five Gulf States, for all fish with fork length less than 975 mm. **Blue dotted lines show the upper and lower 95% confidence limits.**

Monthly Fish Consumption Limits for Methylmercury (USEPA)

<u>Fish meals/month</u>	<u>for Fish Hg ppm</u>	<u>Hg in King Mackerel</u>
16	> 0.03–0.06	
12	> 0.06–0.08	
8	> 0.08–0.12	
4	> 0.12–0.24	Gulf range 0.2-4.5 ppm
3	> 0.24–0.32	
2	> 0.32–0.48	
1	> 0.48–0.97	FDA mean 0.73 ppm
0.5	> 0.97–1.9	
None (<0.5)	> 1.9	

*Adult body weight = 70 kg

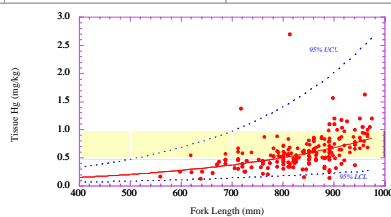
*Average fish meal size = 8 oz. fresh weight

*USEPA's RfD for MeHg, 0.1 microgram/kg-body weight per day

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Calculated King Mackerel fork lengths for specified meal frequencies and corresponding fish mercury concentration ranges

Fish meals/month	Fish Tissue Hg (ppm)	Fork Length (inches) – best fit model	Fork Length (inches) – 97.5% CL
1 meal/month	> 0.48–0.97	30.7 – 40.1	19.7 – 27.4
2 meals/month	> 0.32–0.48	25.4 – 30.7	15.3 – 19.7
3 meals/month	> 0.24–0.32	21.6 – 25.4	12.1 – 15.3
4 meals/month	> 0.12–0.24	12.4 – 21.6	4.5 – 12.1



American Heart Association Scientific Statement

Fish Consumption, Fish Oil, Omega-3 Fatty Acids, and Cardiovascular Disease.

Penny M. Kris-Etherton, PhD, RD; William S. Harris, PhD; Lawrence J. Appel, MD, MPH; for the Nutrition Committee.

SUMMARY

Omega-3 fatty acids have been shown in epidemiological...trials to reduce the incidence of CVD.... Evidence...suggests that EPA+DHA supplementation ranging from 0.5 to 1.8 g/d significantly reduces...cardiac... mortality....

Collectively, these data are supportive of the **recommendation made by the AHA** Dietary Guidelines to include at least **two servings of fish per week** (particularly fatty fish)....

The **fish recommendation** must be **balanced with concerns about** environmental pollutants, in particular PCB and **methylmercury**....

Advisory options

Calculated King Mackerel fork lengths for specified fish mercury levels

Fish meals/month	Fish Tissue Hg (ppm)	Fork Length (inches) – Best fit model	Fork Length (inches) – Model 97.5% CL
1 meal/month	> 0.48–0.97	30.7 – 40.1	19.7 – 27.4
2 meals/month	> 0.32–0.48	25.4 – 30.7	15.3 – 19.7
3 meals/month	> 0.24–0.32	21.6 – 25.4	12.1 – 15.3
4 meals/month	> 0.12–0.24	12.4 – 21.6	4.5 – 12.1

24 inches is legal minimum King Mackerel size



12/11/2003

Advice For Women Who Are Pregnant, Or Who Might Become Pregnant, and Nursing Mothers, About Avoiding Harm To Your Baby Or Young Child From Mercury in Fish and Shellfish.

To protect your baby follow these 3 rules:

1. Do not eat Shark, Swordfish, **King Mackerel**, or Tilefish because they contain high levels of mercury
2. Levels of mercury in other fish can vary. You can safely eat up to 12 ounces (2 to 3 meals) of other purchased fish and shellfish a week. Mix up the types of fish and shellfish you eat and do not eat the same type of fish and shellfish more than once a week.
3. Check local advisories about the safety of fish caught by family and friends in your local rivers and streams. If no advice is available, you can safely eat up to 6 ounces (one meal) per week of fish you catch from local waters, but don't consume any other fish during that week.

Based on the similarity of the fish size – mercury concentration relationships across the Gulf of Mexico, there is scope for a Gulf-wide advisory for King Mackerel that is tied to fish size.

However, Gulf of Mexico King Mackerel mercury concentrations are too high relative to the MeHg reference dose to advocate its use as a routine dietary component in a “heart-healthy diet”.

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QUESTIONS?

Options for a Gulf States’ Mercury Advisory for King Mackerel

**Donald M. Axelrad¹, Curtis D. Pollman²,
George E. Henderson³ and Frederick Kopfler⁴**

¹Florida Department of Environmental Protection, Tel. 850-245-8306

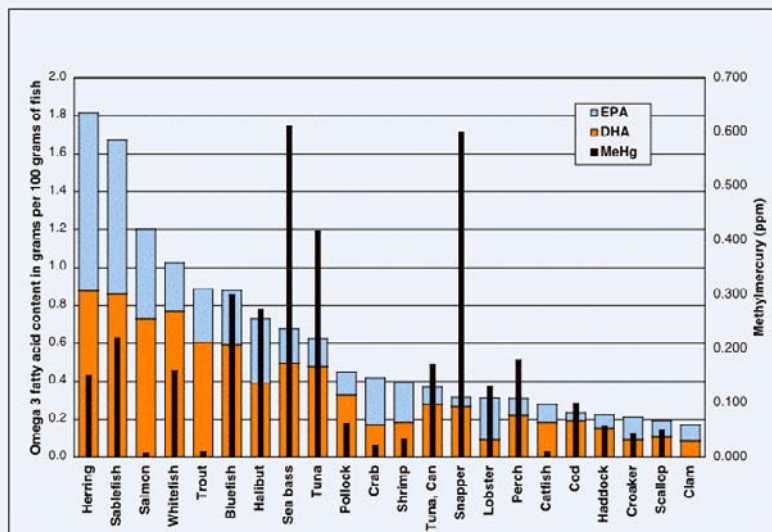
²Tetra Tech Inc.

³Florida Fish and Wildlife Conservation Commission

⁴USEPA Region 4 Gulf of Mexico Program Office

Extra slides follow –

I do not plan to use these extras!



Box 2: Recommendations for intake of omega 3 fatty acid

- Patients without documented coronary heart disease: Eat a variety of (preferably oily) fish at least twice weekly. Include oils and foods rich in α linolenic acid
 - Patients with documented coronary heart disease: Consume 1 g of eicosapentanoic and docosahexanoic acid daily, preferably from oily fish. Supplements could be considered in consultation with a doctor
 - Patients with hypertriglyceridaemia: Take 2-4 g of eicosapentanoic acid and docosahexanoic acid daily, provided as capsules under a doctor's care
- These are the recommendations of the American Heart Association.²⁸

U. S. Food and Drug Administration
May 2001

Mercury Levels in Seafood Species

The following tables provide the mean and range of mercury levels in a variety of fish and shellfish

Table 2,
Fish and Shellfish With Much Lower Mercury Levels

*Crab Blue	0.17	0.02-0.50	94
*Crab Dungeness	0.18	0.02-0.48	50
*Crab Tanner	0.15	ND-0.38	55
*Crab King	0.09	0.02-0.24	29
*Scallop	0.05	ND-0.22	66
*Catfish	0.07	ND-0.31	22
*Salmon (fresh, frozen or canned)	ND	ND-0.18	52
*Oysters	ND	ND-0.25	33
*Shrimps	ND	ND	22

Omega-3 Fatty Acid Content in Fish[†]

Species	Source	LNA* (18:3)	EPA* (20:5)	DHA* (22:6)	Total EPA + DHA	Total Ω-3 FAs
Lake Trout, Siscowet	freshwater	1.6	1.2	1.8	3.0	4.6
Mackerel, Atlantic	marine	0.1	0.9	1.6	2.5	2.6
Mackerel, King	marine	0.0	1.0	1.2	2.2	2.2
Dogfish, spiny	marine	0.1	0.7	1.2	1.9	2.0
Mackerel, Chub	marine	0.3	0.9	1.0	1.9	2.2
Salmon, Atlantic, farmed	marine	0.1	0.6	1.2	1.8	1.9
Herring, Pacific	marine	0.1	1.0	0.7	1.7	1.8
Herring, Atlantic	marine	0.1	0.7	0.9	1.6	1.7
Lake Trout	freshwater	0.4	0.5	1.1	1.6	2.0
Tuna, Bluefin	marine	0.0	0.4	1.2	1.6	1.6
Sturgeon, Atlantic	marine	trace	1.0	0.5	1.5	1.5
Chub	freshwater	1.1	0.7	0.8	1.5	2.6
Salmon, Chinook	both	0.1	0.8	0.6	1.4	1.5
Sablefish	marine	0.1	0.7	0.7	1.4	1.5
Anchovy, European	marine	0.0	0.5	0.9	1.4	1.4
Tuna, Albacore	marine	0.2	0.3	1.0	1.3	1.5
Lake Whitefish	freshwater	0.2	0.3	1.0	1.3	1.5
Sprat	marine	0.0	0.5	0.8	1.3	1.3
Trout, Lean Lake	freshwater	0.9	0.4	0.8	1.2	2.1
Salmon, Coho, farmed	both	0.1	0.4	0.8	1.2	1.3
Bluefish, Atlantic	marine	0.0	0.4	0.8	1.2	1.2
Herring, Round	freshwater	0.1	0.4	0.8	1.2	1.3
Salmon, Sockeye	both	0.1	0.5	0.7	1.2	1.3
Herring	freshwater	1.4	0.5	0.6	1.1	2.5
Capelin	marine	0.1	0.6	0.5	1.1	1.2
Whitefish	freshwater	0.8	0.5	0.5	1.0	1.8
Salmon, Pink	both	trace	0.4	0.6	1.0	1.0
Sardines, canned	marine	0.5	0.4	0.6	1.0	1.4
Salmon, Chum	both	0.1	0.4	0.6	1.0	1.1
Halibut, Greenland	marine	trace	0.5	0.4	0.9	0.9

[†]grams fatty acid per 100 gram edible fish tissue or edible food

*LNA = α-linolenic acid; EPA = eicosapentaenoic acid; DHA = docosahexaenoic acid (only EPA and DHA are omega-3 fatty acids)

Circulation. 2002;106:2747

Fish Consumption, Fish Oil, Omega-3 Fatty Acids, and Cardiovascular Disease

Penny M. Kris-Etherton, PhD, RD, et. al

Evidence...suggests that EPA+DHA supplementation ranging from 0.5 to 1.8 g/d significantly reduces subsequent cardiac and all-cause mortality....

Target: 0.5 to 1.8 gram/day EPA+DHA

King Mackerel has 2.2 gram EPA+DHA per 100 gram of fish = 0.623 gram EPA+DHA per oz. of fish (Charles Santerre, pers. comm.)

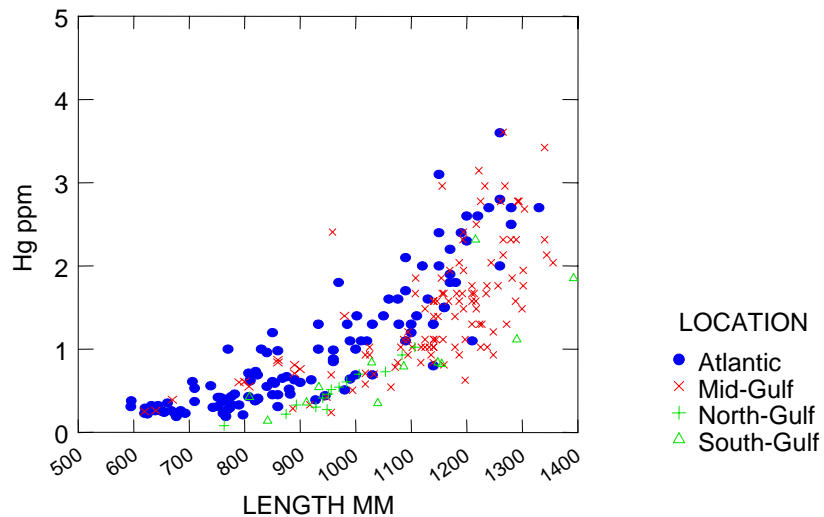
For 0.5 gram/day EPA+DHA: One must consume 36 oz./month (over 4 eight oz. meals) of King Mackerel

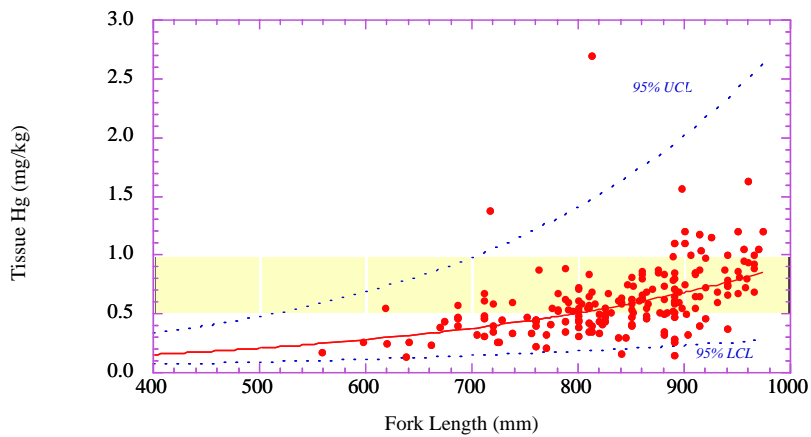
For 1.8 gram/day EPA+DHA: One must consume 129 oz./month (over 16 eight oz. meals) of King Mackerel

TABLE 3. Amounts of EPA+DHA in Fish and Fish Oils and the Amount of Fish Consumption Required to Provide ≈ 1 g of EPA+DHA per Day

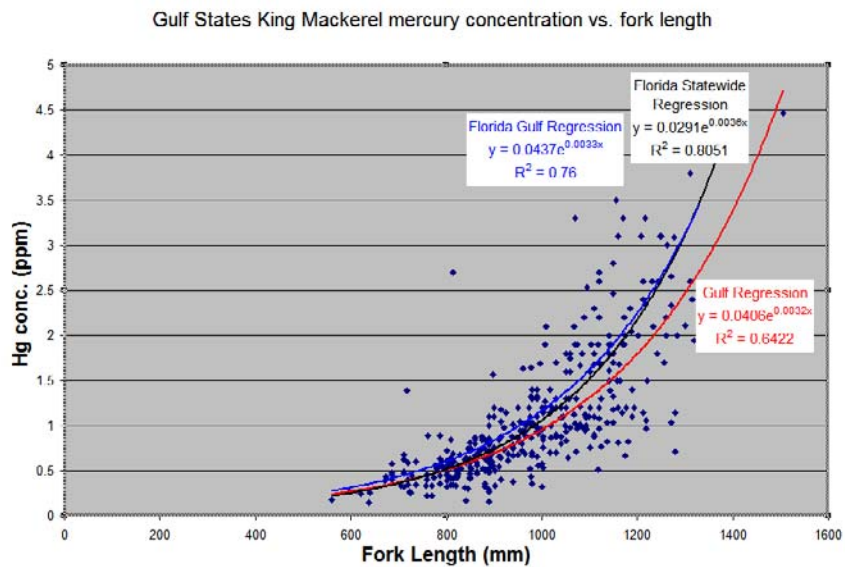
	EPA+DHA Content, g/3 oz Serving Fish (Edible Portion) or g/g Oil	Amount Required to Provide ≈ 1 g of EPA+DHA per Day, oz (Fish) or g (Oil)
Fish		
Tuna		
Light, canned in water, drained	0.26	12
White, canned in water, drained	0.73	4
Fresh	0.24–1.28	2.5–12
Sardines	0.98–1.70	2–3
Salmon		
Chum	0.68	4.5
Sockeye	0.68	4.5
Pink	1.09	2.5
Chinook	1.48	2
Atlantic, farmed	1.09–1.83	1.5–2.5
Atlantic, wild	0.9–1.56	2–3.5
Mackerel	0.34–1.57	2–8.5
Herring		
Pacific	1.81	1.5
Atlantic	1.71	2

King Mackerel Size vs. Hg Concentration, by Florida Geographic Region





Plot of mercury concentrations vs. fork length for King Mackerel collected in the Gulf of Mexico by the five Gulf States, for all fish with fork length less than 975 mm. Blue dotted lines show the upper and lower 95% confidence limits.





KING MACKEREL

KING MACKEREL - *Scomberomorus cavalla*

Family Scombridae, MACKERELS AND TUNAS

Description: color of back iridescent bluish green, sides silvery; streamlined body with tapered head; no black pigment on front of the first dorsal fin; lateral line starts high and drops sharply below the second dorsal fin; young fish often have yellowish spots like those of Spanish mackerel.

Similar fish: cero, *S. regalis*; Spanish mackerel, *S. maculatus*.

Where found: NEARSHORE and OFFSHORE; occasionally taken from piers running into deep water.

Size: common to 20 pounds.

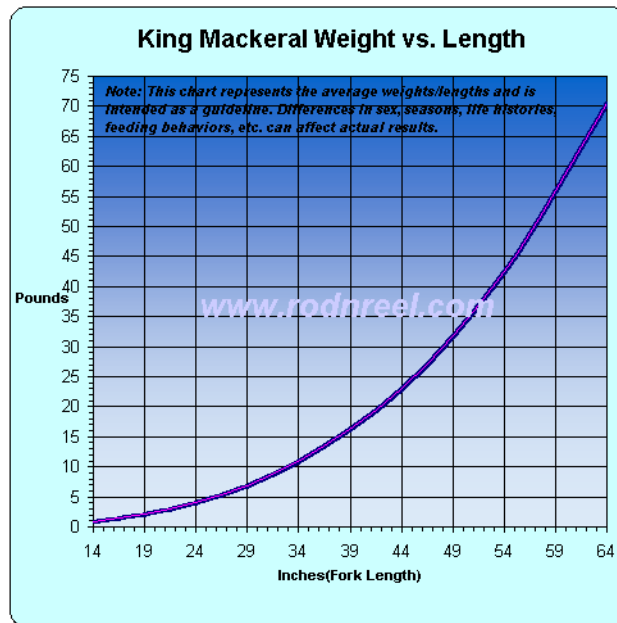
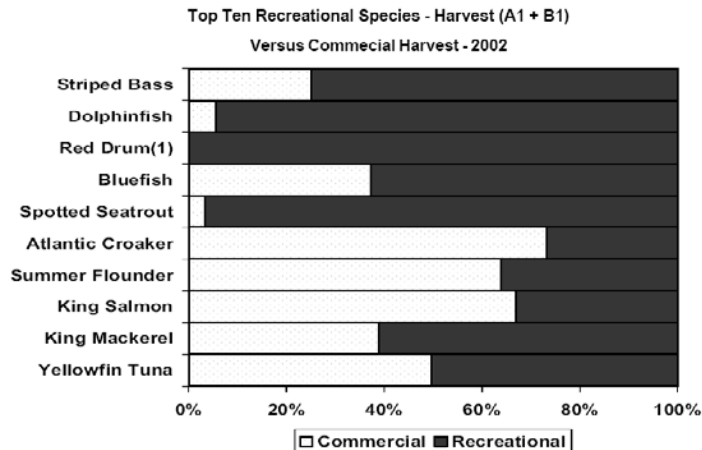
Remarks: schooling fish that migrates from south Florida waters in winter to more northerly waters in spring; Gulf population thought to be separate from Atlantic population, with considerable mixing in winter from Cape Canaveral past Key West; spawns in mid summer OFFSHORE; feeds on small fish and squid.

Florida record: 90 lbs.



U.S. Commercial Landings

Comparisons between the top ten species in descending order of abundance by weight for U.S. commercial landings and recreational fish harvests. Does not include data for Alaska, Hawaii and Texas because no NMFS recreational surveys are conducted in those states. Menhaden, Pacific Hake, Atlantic Sea Herring, Pacific Sardine and Anchovy were excluded from commercial landings because they are industrial fisheries and recreational anglers do not target them.



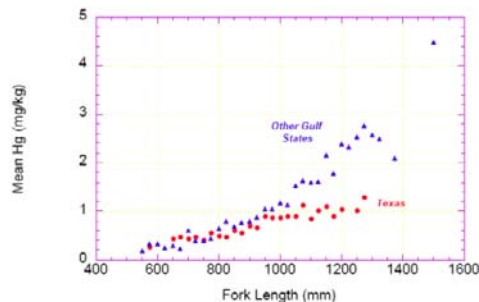
Comparison of Gulf States' Consumption Advisories for King Mackerel resulting from Mercury Contamination

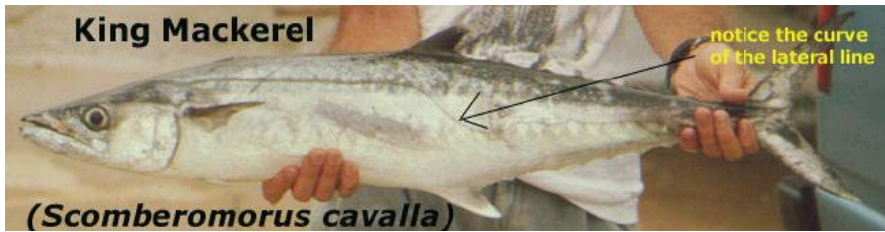
State	No Consumption	Unlimited Consumption	Adults	Women of Childbearing Age	Children
FL	No consumption - king mackerel > 39" fork length.	The advisory does not restrict consumption of king mackerel under 33 inches fork length.	Adults should limit consumption of king mackerel (33" - 39") to one eight-ounce meal per week.	Should limit consumption to one eight-ounce meal per month.	Children less than 11 years old should consume no more than one 8-ounce meal per month.
AL	Advice for everyone: Do not consume king mackerel over 39 inches.	Not Addressed	Adults should limit their consumption of the king mackerel less than 39 inches to one meal per month.	Avoid eating king mackerel from these areas.	Children less than 15 years old should avoid eating king mackerel from these areas.
MS	Do not eat king mackerel greater than 39".	Not Addressed	Adults should eat no more than one meal of 33"-39" king mackerel every two weeks.	Should eat no more than one meal of these fish every two months.	Children under 7 should eat no more than one meal of these fish every two months.
LA	Advice for all individuals: NO consumption of king mackerel greater than 39 inches in total length.	Not Addressed	Limit consumption of all king mackerel 39 inches or less in total length to 4 meals per month. (Includes children 7 years of age and older).	Should limit consumption of all king mackerel 39 inches or less in total length to 1 meal per month.	Children less than 7 years of age should limit consumption of all king mackerel 39 inches or less in total length to 1 meal per month.
TX	The advisory recommends not eating king mackerel longer than 43 inches in total length.	For king mackerel less than 37 inches total length. Safe for unrestricted consumption.	Adults should limit consumption of king mackerel measuring from 37 to 43 inches in total length to one eight-ounce serving per week.	Should limit consumption of king mackerel measuring from 37 to 43 inches in total length to one 8-ounce serving per month.	(No age) limit consumption of king mackerel measuring from 37 to 43 inches in total length to one 8-ounce serving per month.

***This was verified by conducting a paired t-test; results indicate:**

***Below size class 950 mm** (*i.e.*, fish 950 – 974 mm in fork length), there is no significant difference in the King Mackerel fork length – mercury concentration relationship between Texas and the other Gulf States.

***Above size class 950 mm**, Texas King Mackerel do show systematically lower mercury concentrations than fish from the other Gulf States.





Family Scombridae – Mackerels and Tunas

Geographical Distribution: Western Atlantic from Massachusetts to Rio de Janeiro, Brazil.

Interest to Fisheries: King mackerel is an important species for recreational and commercial fisheries throughout its range.

Size: Maximum size is 173 cm fork length and 45 kg weight.

Food: Food consists primarily of fishes with smaller quantities of penaeid shrimps and squids.

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